



## Marine fish traits follow fast-slow continuum along coastal-offshore gradient

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# Marine fish traits follow environmental gradients across European seas

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## Introduction

One of the major goals in biogeography is describing and understanding species distributions. However, when focusing on species-environment relationships, one may miss the mechanistic understanding of what underlies these distributions. Therefore, trait-environment relationships are useful in explaining where species occur, since traits determine which environment a species can inhabit<sup>1</sup>. In this study, we apply this trait-based approach to Europe's marine fish communities.

## Aims of this study

- 1) To identify key traits for marine fish that explain fish species distributions;
- 2) To identify the most important relationships between marine fish traits and the environment.

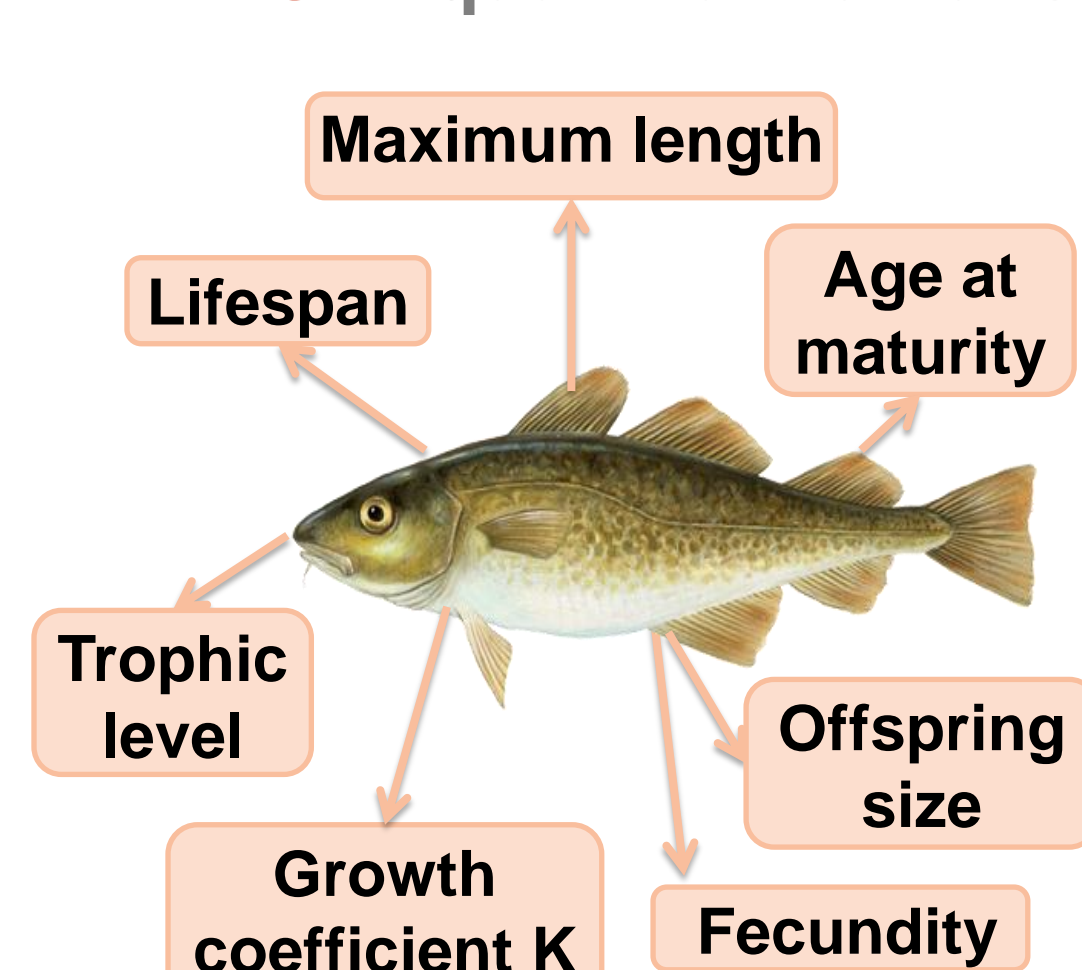
## Data

### SITES & SPECIES:

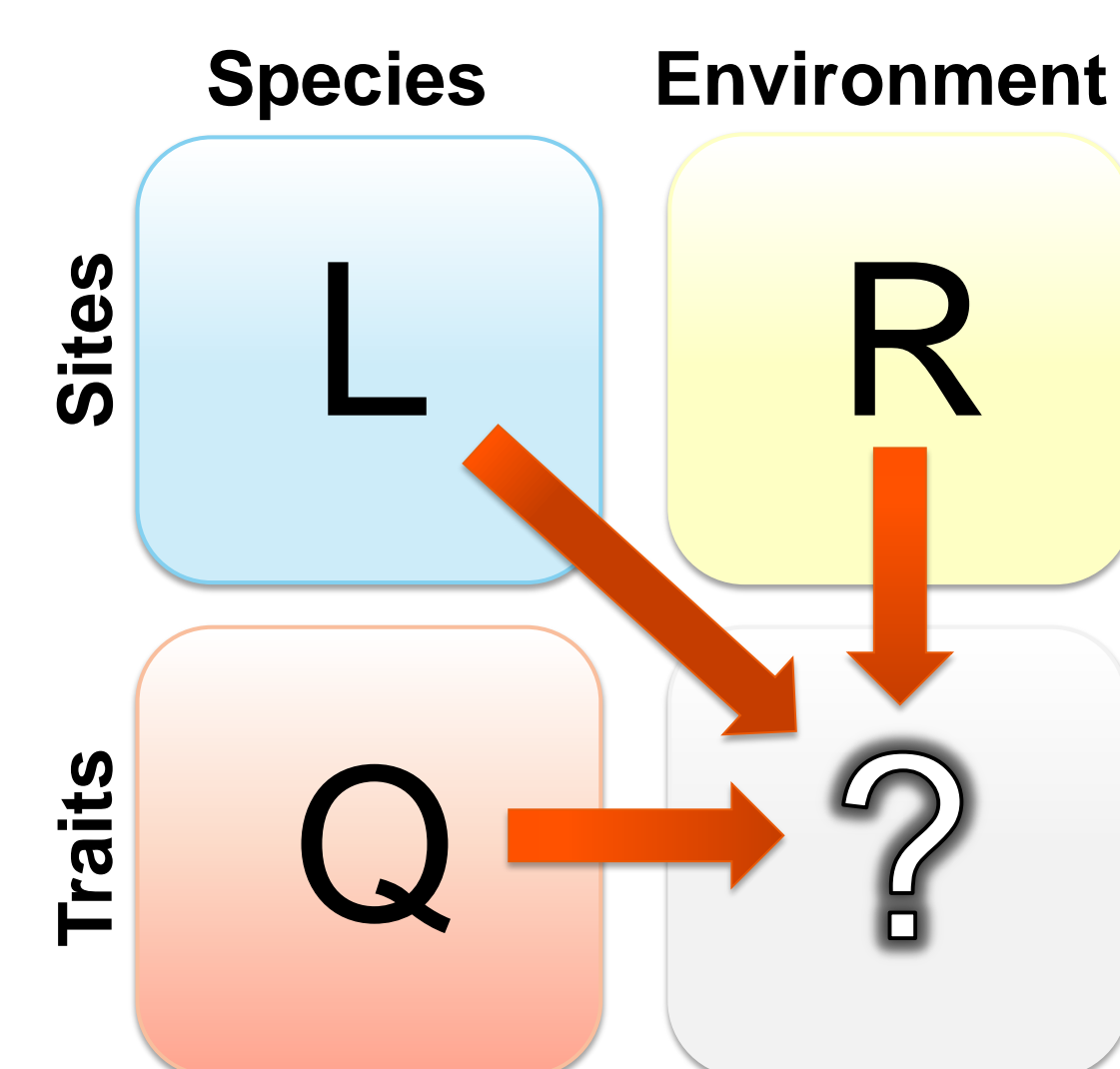
~2200 sampling sites and ~250 species from scientific surveys done in the continental shelf seas of Europe (combination of publicly available and institutional data).

**ENVIRONMENT:** depth, temperature, salinity, Chlorophyll (Chl) concentration, seasonal variability in temperature and monthly variability in Chl-concentration (NOAA; GlobColour).

### TRAITS: 7 quantitative traits



## Methods



### • RLQ analysis<sup>2</sup>

Multivariate ordination approach combining all three datasets (R, L and Q). Gives a score to all data onto the same ordination axes.

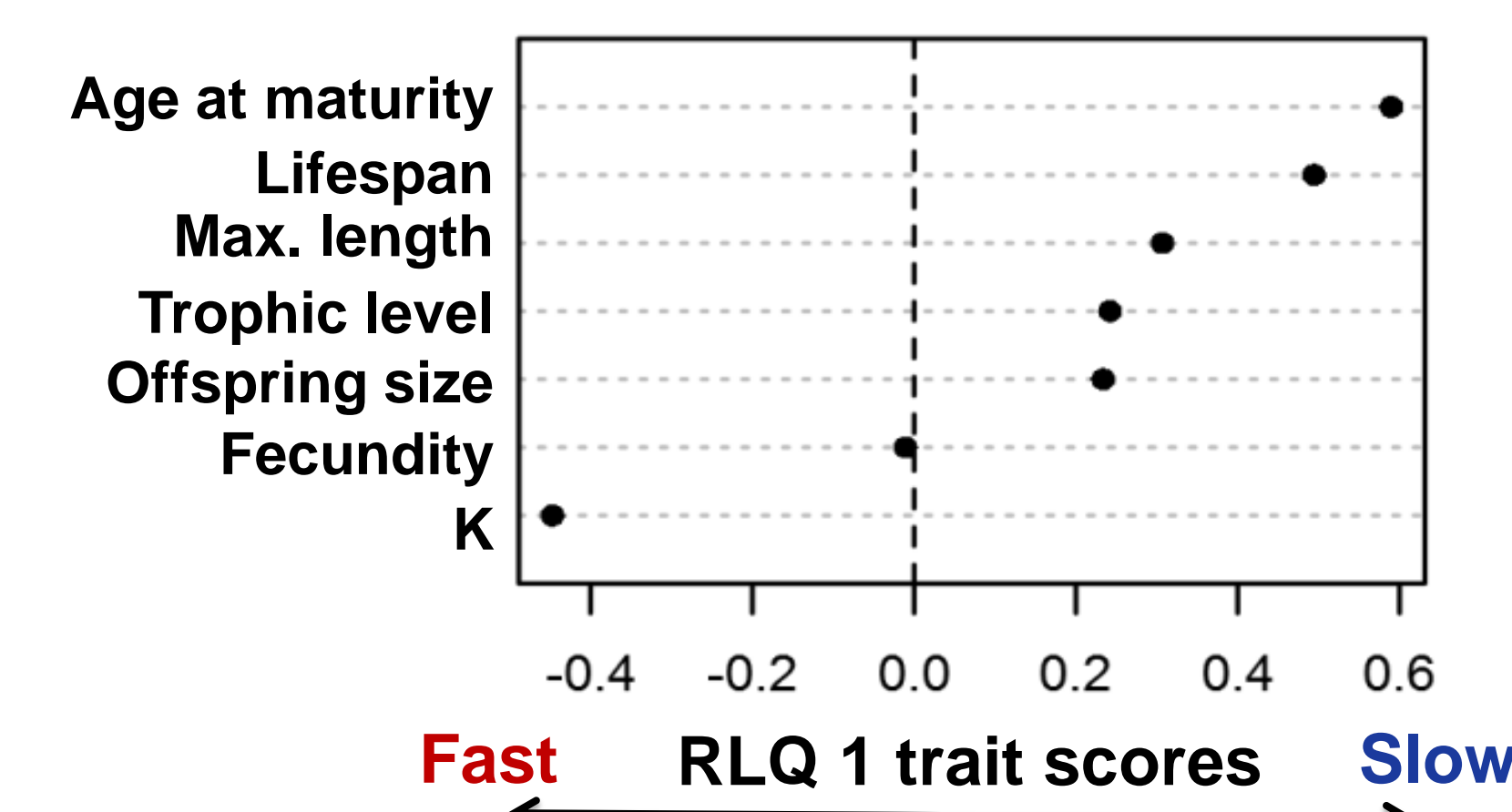
### • Fourth-corner analysis<sup>2</sup>

Makes use of species distributions when testing for correlations between traits and environmental variables.

## Results

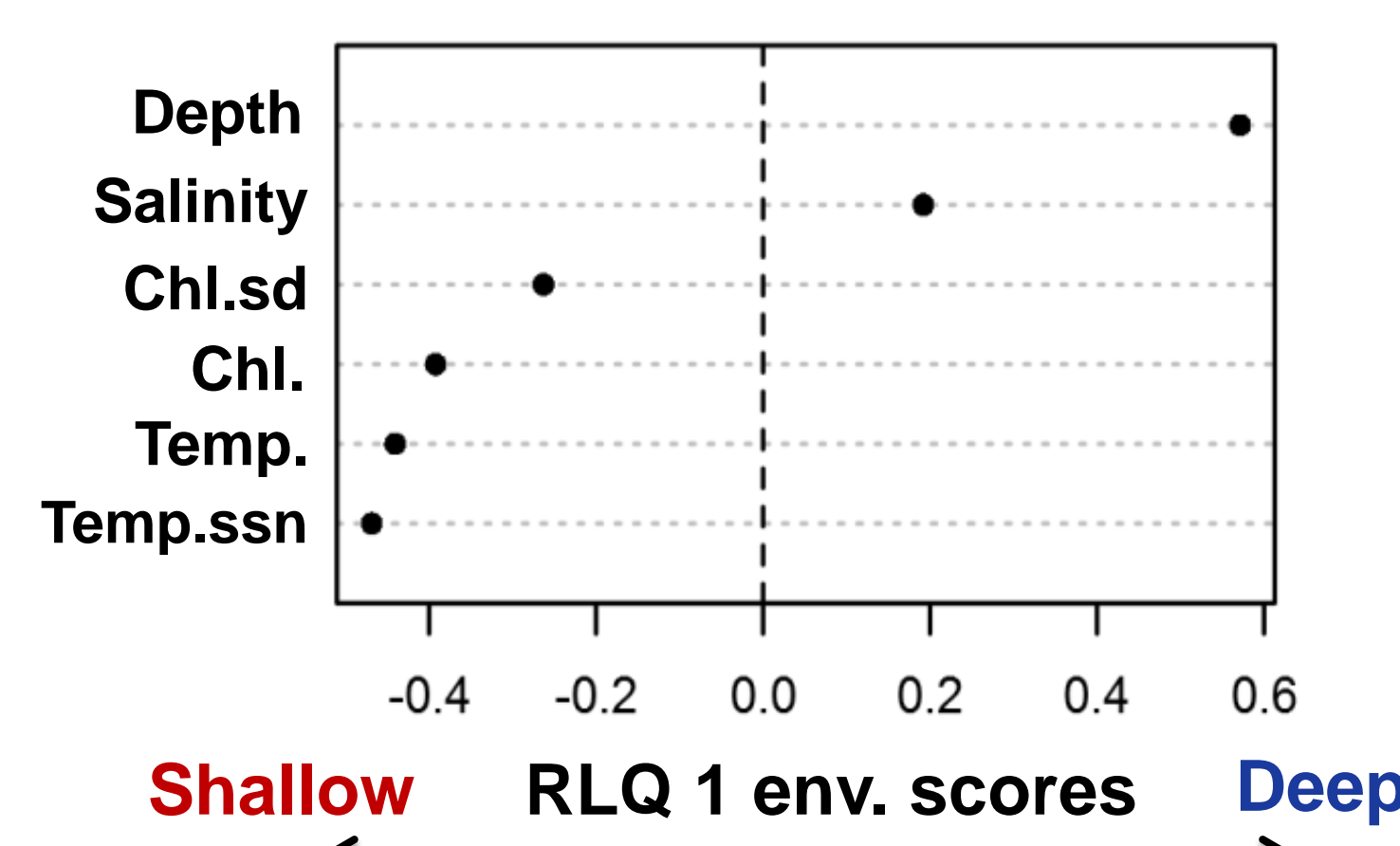
### TRAITS

The first axis of the **RLQ analysis** (RLQ 1) explained 95% of the variation. In terms of traits, RLQ 1 represents a **fast-slow continuum**, mainly characterized by age at maturity, lifespan and the growth coefficient K.



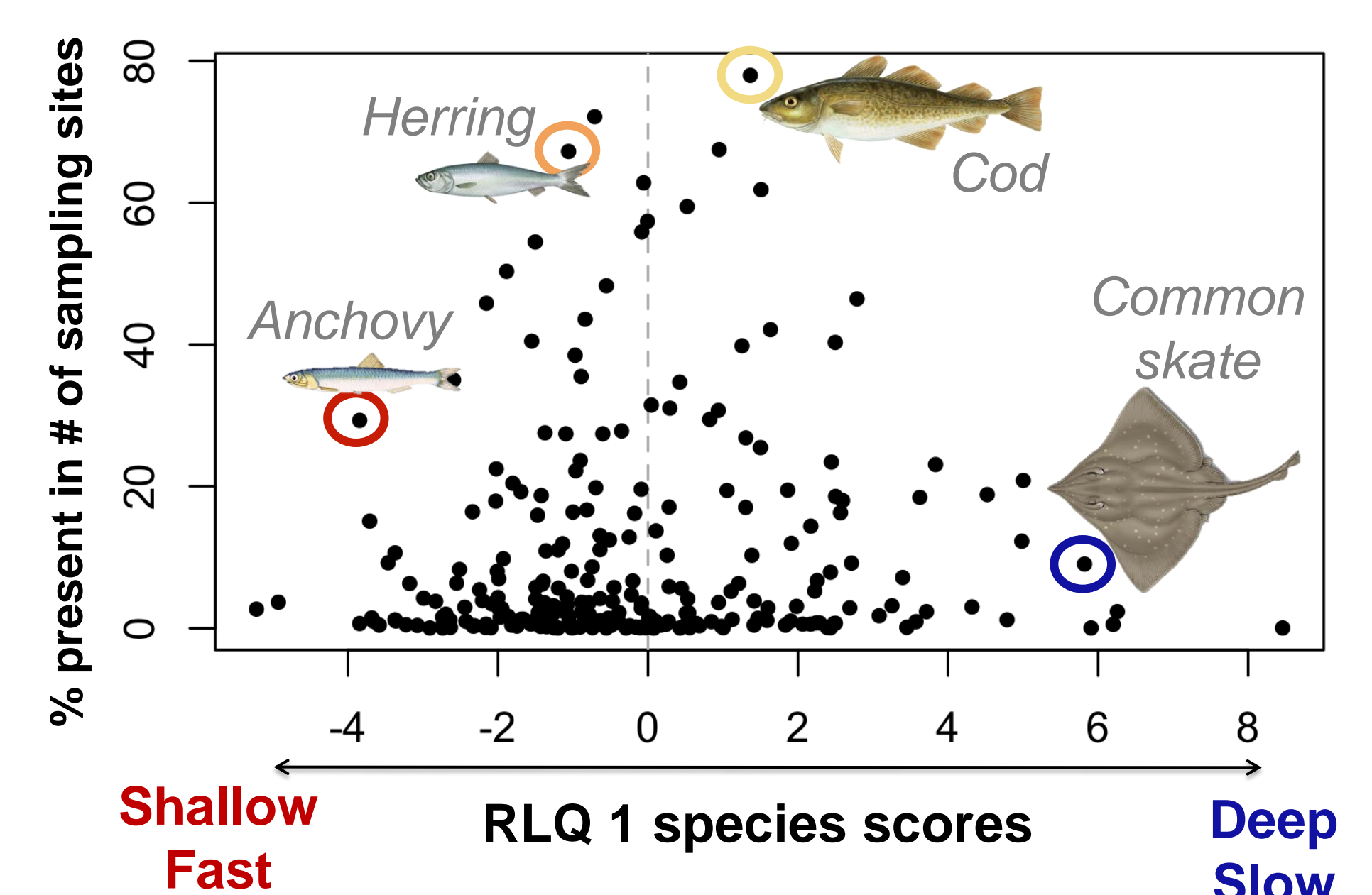
### ENVIRONMENT

RLQ 1 represents a **depth gradient**, along which also vary: temperature (Temp.), seasonal variability in temperature (Temp.ssn), chlorophyll concentration (Chl) and seasonal variability in Chl (Chl.sd).



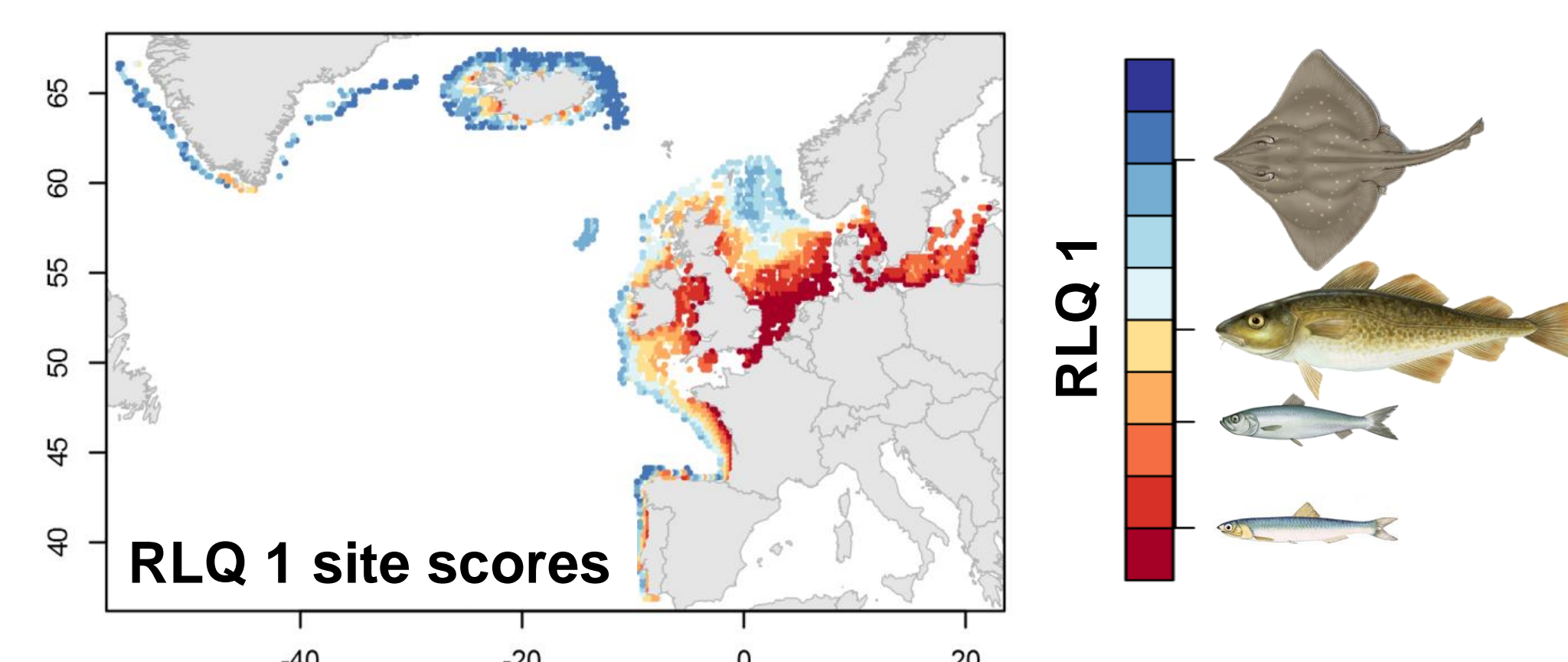
### SPECIES

RLQ 1 identified **specialist species** having typical fast or slow life histories, e.g. anchovy and common skate. **Generalist species**, e.g. Atlantic cod and Atlantic herring, were not strongly characterized by RLQ 1 in terms of their traits and distribution. This indicates that the trait values they have allow them to inhabit a wide range of environments. Indeed, the most common species (i.e. that were present at most sampling sites) were generalist species, whereas typical specialist species were less abundant.



### SAMPLING SITES

The RLQ 1 scores of the sampling sites follow a **coastal-to-offshore gradient**, thereby corresponding to the depth gradient that was found to be an important determinant for fish species distributions.



The **fourth-corner analysis** confirmed the importance of the three traits that characterize the fast-slow continuum as well as depth as an important environmental variable. The analysis also revealed significant relationships of the fast-slow traits with temperature and with the variability in temperature and Chl-concentration.

	Temp.ssn	Chl.sd	Chl	Depth	Temp.	Salinity
Age at maturity	**	**	*	**	**	
Lifespan	**	**	*	**	**	
K	**	**	*	**	**	
Max. length	*					
Trophic level						
Offspring size						
Fecundity						

Significance: + (blue), - (red)

## Conclusions

We demonstrated that marine fish species can be characterized according to their traits along a fast-slow continuum. Traits in particular related to growth and maturity are key for explaining fish species distributions. The trait continuum is strongly determined by a depth gradient. Along this gradient, other factors vary, such as temperature, productivity and seasonality, which help in explaining species distributions and the structure of marine fish communities.

## References

1. Verberk, W. C. E. P. *et al.* Delivering on a promise: integrating species traits to transform descriptive community ecology into a predictive science. *Freshw. Sci.* 32, 531-547 (2007).
2. Dray, S. *et al.* Combining the fourth-corner and the RLQ methods for assessing trait responses to environmental variation. *Ecology* 95, 14-21 (2014).



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